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Research article

The association between climate change attitudes and COVID-19 attitudes: The link is more than political ideology^{☆,☆☆,★}

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ARTICLE INFO

Article History:

Received 12 September 2021

Accepted 5 November 2021

Available online 8 November 2021

ABSTRACT

The COVID-19 pandemic and climate change are two current global threats. This study examined the relationship between climate change attitudes and COVID-19 behaviors and risk perceptions. Drivers of climate change attitudes and COVID-19 behaviors were also assessed. Study participants were an online sample of 520 respondents from a longitudinal study of COVID-19 and well-being in the US. Logistic regression models were used to examine the outcomes of climate change opinions and COVID-19 perceptions and prevention behaviors (perceived COVID-19 risk, mask wearing, social distancing, and vaccine intentions). Covariates included political ideology, conspiracy beliefs, and trust in scientific information about COVID-19. In the multivariable models of COVID-19 perceptions and prevention behaviors, climate change opinions were also included as a covariate. In these models, climate change attitudes were significantly associated with perceived risk of COVID-19, always wearing masks, decreased time spent with others due to COVID-19, and intention to get a COVID-19 vaccine. In adjusted models, the odds of wearing a mask increased 41% (CI: 1.11–1.78) for every 1-point increase on the climate attitude scale and decreased 13% (CI: 0.79–0.96) if the participant distrusted COVID-19 information. Those who reported distrust of COVID-19 information (aOR: 1.61, CI: 1.40–1.85), politically conservative ideology (aOR: 1.24, CI: 1.04–1.47), lower concern about climate change (aOR: 0.71, CI: 0.53–0.97), female sex (aOR: 2.39 CI: 1.38–4.13), and lower disbelief in conspiracy theories (aOR: 0.63, CI: 0.51–0.80) had higher odds of not intending to be vaccinated. These findings suggest that climate change attitudes are linked to COVID-19 behaviors and perceptions, which are not completely driven by political ideology or trust in scientific information.

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While community, state, and national prevention resources have been focused on mitigating the COVID-19 pandemic, climate change looms as a concurrent global crisis. Furthermore, climate change will likely accelerate the speed with which future infectious disease outbreaks occur, through increased interactions between humans and other species as well as altered geographic ranges of infectious disease vectors [1–3]. The two crises share commonalities, with each linked to political polarization, downplaying of severity, and distrust in science [4,5]. Given the commonalities of these crises, understanding factors associated with COVID-19 mitigation and the

interplay between COVID-19 and climate change can provide critical insight into how the public can be motivated to address climate change and lessen future disasters. This study aims to assess how COVID-19 attitudes and behavior and climate change attitudes may be linked, first by examining the associations between them and then by assessing whether we can discern common factors that may drive these two seemingly disparate phenomena. At the time of data collection for this study, over 250,000 COVID-19 deaths and 12 million cases had been confirmed in the US with over 4.5 million deaths and 215 million cases worldwide. Regarding climate change, 2020 was tied for the warmest year ever recorded. In 2020, major climate events occurred, including vast Australian bush fires which burned over 45 million acres; in the US, five of the 10 largest wildfires on record in California occurred, setting a state record for acres burned.

Several shared drivers of attitudes about the COVID-19 and climate change crises have been identified. One primary driver is political ideology. Multiple studies in the US have documented that political ideology is strongly linked to climate change attitudes. Individuals who identify as liberal, as compared to conservative, are

[☆]Ethical Approval: The research protocols were approved by the Johns Hopkins Bloomberg School of Public Health IRB.

^{☆☆}Consent to Participate: All study participants were provided an informed consent form and indicated that they agreed to participate.

[★]Consent to Publish: All authors read and approved the final version.

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more likely to believe that climate change is caused by humans, to be concerned about harms caused by climate change, and to support actions to address it [6–11]. Political ideology has also impacted how the COVID-19 pandemic has both been handled by various governments and perceived by their constituents [12,13]. In the US, the Trump administration's decision to downplay the risk of COVID-19, amplified by conservative media outlets such as Fox News, facilitated political polarization in both perceptions of and responses to the pandemic [14]. Indeed, political ideology was found to be associated with COVID-19 prevention behaviors such as mask wearing, frequent handwashing, decreased time spent with others, and standing at least 6-feet apart when interacting with others [14–16].

In addition to political ideology influencing attitudes and sources of information about climate change and the COVID-19 pandemic, political beliefs and ideologies might serve as a source of motivated reasoning, with conservatives avoiding information on the actual severity of the COVID-19 pandemic due in part to conservative leaders and media outlets downplaying the pandemic's severity, thus engaging in fewer prevention behaviors. Motivated cognitions have been well-studied in the field of climate change [17]. Prior research on motive cognitions finds that Republicans are less likely to spend time reading climate change articles or viewing graphs about global temperatures than Democrats [18,19].

In the US, political polarization in recent decades has also been associated with greater distrust among conservatives in the use of scientific evidence to guide policymaking. Distrust in science may affect not only attitudes about the COVID-19 pandemic but also COVID-19 prevention behaviors and COVID-19 vaccine intentions [20–22]. Distrust in science is not unique to the COVID-19 pandemic. Trust in scientific information has previously been associated with climate change attitudes, with those who believe that scientists manipulate their data more likely to deny that climate change is real and report less trust in climate science agencies [23].

Finally, another shared association between the COVID-19 pandemic and climate change is the proliferation of conspiracy theories surrounding both crises. In the US, high levels of conspiracy theories have been documented in recent years. An NPR/Ipsos poll conducted in late December 2020 found that 40% of Americans surveyed believe that COVID-19 was created in a lab in China, 39% agreed there was a deep state working to undermine the Trump presidency [24], and almost one-quarter of Republicans thought that “A group of Satan-worshipping elites who run a child sex ring are trying to control our politics and media,” with an additional 38% responding “Don't know” to this statement. Research on conspiracy theories and climate change attitudes finds a strong association between conspiracy beliefs and downplaying the current climate change emergency [25,26]. There is also an emerging body of literature on the association between belief in conspiracy theories and adoption of COVID-19 prevention behaviors, such as mask wearing, social distancing, and intentions to obtain a COVID-19 vaccine [27–29]. Consequently, we examined the extent to which belief in conspiracy theories is associated with attitudes toward climate change and COVID-19 attitudes.

In the current study, using an online sample of US respondents, we first examined the associations between attitudes towards climate change and COVID-19 perceptions and prevention behaviors, including mask usage, social distancing, and vaccine intentions. We assessed whether these factors were also correlated with trust in information about COVID-19 from scientific organizations, political ideologies, and belief in conspiracy theories. We then used multivariable logistic regression models to examine the independent association of climate change attitudes with COVID-19 attitudes and behaviors, adjusting for trust in information about COVID-19 from scientific organizations, political ideology, and conspiracy theories. We examined whether trust in information about COVID-19 from scientific organizations, political ideology, and conspiracy theories was independently associated with climate change attitudes. Finally, we

examined the association between climate change attitudes and COVID-19 behaviors and attitudes and whether this association would be significantly attenuated when adjusting for political ideology and distrust in scientific sources of COVID-19 information. Understanding these dynamics may help to tailor health communication and public engagement strategies for both climate change and COVID-19 and potentially inform future pandemic responses.

Methods

Study respondents participated in an online longitudinal study that began in March 2020. The study aimed to examine individual, social, and societal-level fluctuations in experiences and perceptions amidst the rapidly changing landscape of the COVID-19 pandemic. Study periods occurred every few months and sought to capture changes in scientific knowledge of infection, the extent of infectious spread, and progress in vaccine development. All respondents who successfully completed the first survey were invited to participate in the subsequent rounds of data collection. Study respondents completed the first survey between March 24th–27th, 2020, after many governors had declared States of Emergency and enacted social distancing measures. By March 24th, 2020, 15 states had implemented statewide Stay At Home orders, including California, Connecticut, Delaware, Illinois, Indiana, Louisiana, Massachusetts, Michigan, New Jersey, New Mexico, New York, Ohio, Oregon, Washington, and West Virginia. By March 26th, 2020, 21 states had enacted statewide Stay At Home orders. Study respondents were invited to participate in the second survey between May 5th–14th, 2020, and the third survey from July 22nd–30th, 2020. At that time, there had been over 140,000 COVID-19 deaths in the US. The fourth wave of the study was administered from November 18th–28th, 2020, after **Pfizer- BioNTech** (November 9th) and Moderna (November 16th) presented preliminary Phase 3 data indicating that their COVID-19 vaccines were efficacious but before any COVID-19 vaccine was approved by the US Food and Drug Administration or available to the public. There were 584 valid surveys at wave four and 520 individuals who completed both wave three and wave four surveys.

Study participants were recruited through Amazon's Mechanical Turk (MTurk) service. This approach is regularly used by health researchers, as it allows for a diverse sample to be collected in a rapid and timely fashion [30]. Prior research has indicated that samples collected through MTurk provide better quality data in less time than other methods for recruiting convenience samples [31]. Study populations recruited through MTurk are not nationally representative but have been documented to outperform other opinion samples on several dimensions [32]. Studies using MTurk have also demonstrated good reliability [33]. The survey followed MTurk's best practices for research, which included ensuring participant confidentiality, protecting study integrity, generating unique completion codes, integrating attention-checks throughout the survey, repeating study-specific qualification questions, and removing disqualified participants [31,34,35].

Moreover, the demographic characteristics of MTurk appear to be stable [36]. Although MTurk is open to all US residents age 18 or older, respondents tend to be more liberal than the general public, but those who are conservative do not significantly differ in their attitudes from conservatives recruited from other sources [37]. Eligibility included being age 18 or older, living in the United States, being able to speak and read English, having heard of the coronavirus or COVID-19, and providing written informed consent. To enhance study validity, eligible participants had to pass attention and validity checks embedded in the survey. Participants were paid \$2.50 for completing the first survey, \$3.00 for the second, \$3.50 for the third, and \$4.00 for the fourth, which was equivalent to approximately \$12 per hour. The study protocols were approved by the Johns Hopkins Bloomberg School of Public Health Institutional Review Board.

Measures

The outcome variables were engagement in COVID-19 prevention behaviors, perceived risk of COVID-19, and climate change attitudes. These items were measured at wave 4, which was administered prior to the availability of the COVID-19 vaccine. The three COVID-19 related behavioral outcome variables were mask wearing, social distancing, and vaccine intention. These were assessed with the survey items: "Do you wear a face mask when you are outside?" (with the options of "Never," "Sometimes," and "Always," which was dichotomized to "Never" versus "Sometimes" or "Always") and "Are you trying to spend less time around other people to prevent getting the coronavirus?" (with the response options of "Yes" and "No"). Based on prior vaccine hesitancy surveys, we also included vaccine intention as an outcome variable based upon the question: "I am very likely to get a coronavirus vaccine, when available." The response options were "Strongly agree," "Agree," "Neither agree nor disagree," "Disagree," and "Strongly disagree." These items were trichotomized for analysis as positive intentions ("Strongly agree/Agree"), ambivalence ("Neither agree nor disagree"), and negative intentions ("Disagree/Strongly disagree").

Four survey items were used to assess perceived COVID-19 risk. These included: "If I got the coronavirus, it's likely that I would get very sick," "People I'm close to may die from the coronavirus," "I am very worried about my family and friends getting the coronavirus," and "I am very worried about getting the coronavirus." The response categories were "Strongly agree (5)," "Agree (4)," "Neither agree nor disagree (3)," "Disagree (2)," and "Strongly disagree (1)." The Cronbach's alpha for the 4-item perceived COVID-19 measure was 0.84. For the logistic regression models, a median split was used to differentiate between high and low perceived risk.

We assessed climate change attitudes using two standard questions: "How concerned are you about climate change?" and "The future of many young people will be much worse due to climate change." In addition, we included the items: "With everything else going on in the world, I don't have much interest in climate change," and the behavior of "I tend to avoid news on climate change." The first question had response categories of "A great deal (5)," "Quite a bit (4)," "Some (3)," and "Very little or none (2)." The latter three questions had the response categories of "Strongly agree (5)," "Agree (4)," "Neither agree nor disagree (3)," "Disagree (2)," and "Strongly disagree (1)." Exploratory principal component analysis revealed one factor that accounted for 73% of the variance. After the reverse coding of the negatively worded statements, these items were added together for a scale with a range from 5 to 20, with a Cronbach's alpha of 0.87. We also used a median split at 16 to dichotomize the climate change attitude scale when it was used as a dependent variable.

Three key predictors were (1) distrust in sources of COVID-19 information, (2) political ideology, and (3) having conspiracy beliefs. To assess distrust in sources of COVID-19 information, a set of questions asked participants, "How much do you trust information from [...] about coronavirus?" The following were sources of information: the CDC, Johns Hopkins University (which hosts the online COVID-19 tracker), and your State Health Department were included. Response options were "A great deal (1)," "Quite a bit (2)," "Some (3)," and "Very little or none (4)." Based on factor analyses, these items were added together for a scale with a range from 3 to 12, with a Cronbach's alpha of 0.80. Political ideology was assessed with the question, "Where would you place yourself on a scale running from 'Very liberal' to 'Very conservative?'" The response categories were "Very Liberal (1)," Liberal (2)," Slightly Liberal (3)," "Moderate (4)," "Slightly Conservative (5)," "Conservative (6)," and "Very Conservative (7)." Conspiracy beliefs were measured by the standard question of, "Much of what happens in the world today is decided by a small and secretive group of individuals," with response categories of "Strongly agree (1)," "Agree (2)," "Neither agree nor disagree (3)," "Disagree (4)," and "Strongly disagree (5)" with higher scores indicating disbelief in the conspiracy item [38].

Gender, education, and income were also assessed. Level of education was collapsed to reflect some college or less versus bachelor's degree or higher. Income was dichotomized at the median of \$60,000 or below. The response categories for self-reported race/ethnicity included "White," "Non-Hispanic Black," "Asian," "Hispanic," "Mixed," or "Other." All demographic variables were collected during the first wave.

Analyses

To examine common significant covariates among COVID-19 attitudes and behaviors and climate change attitudes, descriptive analyses and logistic univariable and multivariable regression models were used to evaluate outcomes of the level of concern about climate change, perceived risk of COVID-19, mask wearing, social distancing, and vaccine intentions. Three vaccine intention groups were examined: those with (1) positive vaccine intentions, (2) ambivalent intentions, and (3) negative intentions. Multinomial models were used to model the three-level vaccine intention variable. There was no evidence of collinearity in the multivariable models. For the multivariable logistic regression models, all sociodemographic variables and other variables with a p-value of <0.20 in the bivariate models were included in the final adjusted model [39,40]. In order to compare the models, if one of the covariates met this criterion in one of the bivariate models, it was included in all of the multivariable models. We excluded the variable of race/ethnicity due to small Ns in some of the cells.

Results

Sociodemographic characteristics of the study population are presented in Table 1. Of the 520 participants, the median age was

Table 1
Characteristics of the 520 participants who completed the surveys at waves 1, 3, and 4.

Characteristic	N
Perceived risk of getting COVID-19	520
Low risk	270 (51.9%)
High risk	250 (48.1%)
Mask wearing in public	
Sometimes or never	183 (35.2%)
Always	337 (64.8%)
Decreased time spent with others	
Yes	456 (87.7%)
No	64 (12.3%)
COVID-19 vaccine intent	
Intending to get the vaccine	297 (57.1%)
Ambivalence	92 (17.7%)
Not intending to get the vaccine	131 (25.2%)
Climate change attitudes ^{a,b}	16.0 (13.0–18.0)
Age ^a (years)	38.0 (32.0–48.5)
Sex	
Male	224 (43.1%)
Female	296 (56.9%)
Race	
White	421 (81.0%)
Black	31 (6.0%)
Asian	36 (6.9%)
Other	32 (6.2%)
Annual income	
Less than \$60,000	279 (53.7%)
\$60,000 or more	241 (46.3%)
Education level	
Some college or less	224 (43.1%)
Bachelor's degree or more	296 (56.9%)
Endorsement of conspiracy theory ^{a,c}	4.0 (3.0–5.0)
Political ideology ^{a,d}	3.0 (2.0–5.0)
Trust in scientific information regarding COVID-19 ^{a,e}	6.0 (4.0–8.0)

^a Median (IQR).

^b Scale range: 1 (low concern) and 20 (high concern).

^c Scale range: 1 (strongly trust) and 12 (strongly distrust).

^d Range: 1 (very liberal) to 7 (very conservative).

^e Range: 1 (strongly agree) to 5 (strongly disagree).

38 years (IQR: 32–46 years), 56.9% ($n = 296$) were female, and 81% ($n = 421$) self-identified as White race. Roughly half ($n = 270$, 52.0%) of the participants stated that they were worried about getting COVID-19. When asked about engagement in COVID-19 prevention measures, nearly two-thirds ($n = 337$, 64.8%) of the participants stated that they “Always” wore a face mask when they went outside, compared to 35.2% ($n = 183$) who reported “Sometimes” or “Never,” and 87.7% ($n = 456$) said they had decreased the amount of time spent around other people. Almost 60% ($n = 297$, 57.1%) of the participants reported that they were very likely to receive the COVID-19 vaccine once it became available. By comparison, 25.2% ($n = 131$) and 17.7% ($n = 92$) stated that they were not likely to get the vaccine or were ambivalent, respectively. We found that the mean for the climate change attitude scale was 15.20 (Median=16, SD=3.96, range 5–20), suggesting that, on average, the concern for climate change was skewed to the high end. The trust in COVID-19 information sources scale had a range of 3–12 with a mean of 6.2 (Median=6, SD=2.28), and the perceived risk of COVID-19 scale had a range of 4–12 with a mean of 10.3 (Median=9.5, SD=3.72).

Predictors of the perceived risk of infection, personal prevention measures, and climate change beliefs are presented in Tables 2a and 2b. In the univariable analysis, found in the righthand columns, we found that distrust of COVID-19 related information from official sources (CDC, Johns Hopkins University, and health departments) (OR: 0.77, CI: 0.71–0.84), and conservative political beliefs (OR: 0.71, CI: 0.64–0.79) were both associated with lower perceived risk of COVID-19. By contrast, for every 1-point increase on the climate change attitude scale, the odds of greater perceived risk of COVID-19 more than doubled (OR: 2.03, CI: 1.66–2.48). Similarly, not believing that the government was run by a small secretive group of people was also associated with higher perceived risk of COVID-19 (OR: 1.21, CI: 1.04–1.39), but the association did not persist in the adjusted model. In the multivariable analyses, the relationships between perceived risk of COVID-19 and more liberal political ideology (aOR: 0.84, CI: 0.73–0.95), greater trust in public health sources of COVID-19 information from public health sources (aOR: 0.85, CI: 0.76–0.93), and concerns regarding climate change (aOR: 1.53, CI: 1.20–1.95) persisted, although the associations were attenuated.

In terms of efforts made to prevent COVID-19 transmission, results from the univariable analysis found that the odds of more frequent mask wearing were lower among participants with conservative political ideology (OR: 0.74, CI: 0.67–0.83) and those who distrusted public health sources of information (OR: 0.79, CI: 0.72–0.85). We did find that the odds of mask wearing were higher among individuals who reported concern regarding climate change (OR: 1.84, CI: 1.53–2.22) and those who did not believe in conspiracy theories (OR: 1.30, CI: 1.12–1.50). In the multivariable model, the odds of wearing a mask increased 41% (CI: 1.11–1.78) for every 1-point increase on the climate attitude scale and decreased 13% (CI: 0.79–0.96) if the participant distrusted COVID-19 information. When participants were asked how COVID-19 impacted the amount of time spent with others, the odds of decreasing the amount of time spent with others were lower if a participant did not trust official sources of COVID-19 information (OR: 0.66, CI: 0.58–0.75) and had conservative political beliefs (OR: 0.63, CI: 0.54–0.74). However, decreasing the amount of time spent with others was positively associated with concern for climate change (OR: 2.57, CI: 1.98–3.34), disbelief in conspiracy theories (OR: 1.66, CI: 1.34–2.06), and female sex (OR: 1.97, CI: 1.16–3.35). In the multivariable analyses, distrust in COVID-19 information from public health sources (aOR: 0.78, CI: 0.67–0.91) and conservative political opinions (aOR: 0.79, CI: 0.65–0.97) continued to be associated with no decrease in time spent with others. Increasing concern about climate change (aOR: 1.71, CI: 1.22–2.39) was positively associated with decreased time spent with others due to COVID-19 in the adjusted model.

With respect to vaccine hesitancy, compared to participants that were likely to get the COVID-19 vaccine, groups who were undecided about the vaccine tended to be distrustful of scientific information about COVID-19 (OR: 1.35, CI: 1.20–1.53), have conservative political opinions (OR: 1.16, CI: 1.01–1.33), and believed in conspiracy theories (OR: 0.70, CI: 0.57–0.86) in the univariable analysis. Only distrust of COVID-19 related information remained significantly associated with indifference to the COVID-19 vaccine (aOR: 1.32, CI: 1.16–1.51) in the multivariable regression model. Similarly, compared to participants who planned on getting the COVID-19 vaccine, the odds of not intending to be vaccinated were higher if the participant did not trust

Table 2a

Association between climate change and perception of COVID-19 risk and COVID-19 prevention behaviors among 520 respondents who completed surveys at waves 1, 3, and 4.

	Participant had higher perceived risk of COVID-19 ^a		Participant always wore a mask in public ^b		Participant decreased time spent with others due to COVID-19 ^c	
	OR (95% CI)	aOR (95% CI)	OR (95% CI)	aOR (95% CI)	OR (95% CI)	aOR (95% CI)
Climate change attitudes ^d	2.03 (1.66, 2.48)	1.53 (1.20, 1.95)	1.84 (1.53, 2.22)	1.41 (1.11, 1.78)	2.57 (1.98, 3.34)	1.71 (1.22, 2.39)
Increasing distrust in sources of COVID-19 information ^e	0.77 (0.71, 0.84)	0.85 (0.76, 0.93)	0.79 (0.72, 0.85)	0.87 (0.79, 0.96)	0.66 (0.58, 0.75)	0.78 (0.67, 0.91)
Age (years)	1.00 (0.98, 1.01)	1.01 (0.99, 1.02)	0.99 (0.97, 1.01)	0.99 (0.98, 1.01)	1.01 (0.99, 1.03)	1.02 (1.00, 1.05)
Sex						
Male	Ref	Ref	Ref	Ref	Ref	Ref
Female	1.51 (1.06, 2.14)	1.47 (1.00, 2.15)	1.42 (0.99, 2.04)	1.43 (0.96, 2.11)	1.97 (1.16, 3.35)	1.76 (0.97, 3.19)
Total family income last year						
<\$60,000	Ref	Ref	Ref	Ref	Ref	Ref
≥\$60,000	0.80 (0.57, 1.13)	0.84 (0.56, 1.24)	0.87 (0.61, 1.24)	0.88 (0.59, 1.32)	1.13 (0.66, 1.91)	1.35 (0.70, 2.59)
Level of education						
Some college or less	Ref	Ref	Ref	Ref	Ref	Ref
Bachelor's or graduate degree	0.97 (0.68, 1.37)	0.81 (0.55, 1.21)	1.08 (0.75, 1.55)	0.92 (0.61, 1.39)	1.03 (0.61, 1.75)	0.65 (0.34, 1.24)
Political ideology ^f	0.71 (0.64, 0.79)	0.84 (0.73, 0.95)	0.74 (0.67, 0.83)	0.89 (0.78, 1.01)	0.63 (0.54, 0.74)	0.79 (0.65, 0.97)
Disbelief in conspiracy theories ^g	1.21 (1.04, 1.39)	0.93 (0.78, 1.11)	1.30 (1.12, 1.50)	1.06 (0.89, 1.27)	1.66 (1.34, 2.06)	1.14 (0.88, 1.48)

OR=odds ratios, aOR=adjusted odds ratios.

^a Reference group: lower perceived risk of COVID-19.

^b Reference group: sometimes or never wearing a mask in public.

^c Reference group: the participant did not decrease time spent with others due to COVID-19.

^d Scale range: 1 (low concern) to 20 (high concern).

^e Scale range 1 (strongly trust) to 12 (strongly distrust).

^f Range: 1 (very liberal) to 7 (very conservative).

^g Range: 1 (strongly agree) to 5 (strongly disagree).

Table 2b

Association between climate change attitudes and vaccine hesitancy and correlates of climate change attitudes (N = 520).

	Participant undecided whether to get COVID-19 vaccine ^{a,b}		Participant did not intend to get COVID-19 vaccine ^{a,b}		Participant was highly concerned about climate change ^c	
	OR (95% CI)	aOR (95% CI)	OR (95% CI)	aOR (95% CI)	OR (95% CI)	aOR (95% CI)
Climate change attitudes ^d	0.83 (0.64, 1.07)	1.21 (0.88, 1.68)	0.41 (0.33, 0.51)	0.71 (0.53, 0.97)		
Increasing distrust in sources of COVID-19 information ^e	1.35 (1.20, 1.53)	1.32 (1.16, 1.51)	1.87 (1.66, 2.12)	1.61 (1.40, 1.85)	0.68 (0.62, 0.75)	0.75 (0.67, 0.83)
Age (years)			0.99 (0.98, 1.01)	0.98 (0.96, 1.00)	1.00 (0.98, 1.01)	1.01 (0.99, 1.03)
Sex						
Male	Ref	Ref	Ref	Ref	Ref	Ref
Female	0.81 (0.51, 1.30)	0.91 (0.56, 1.49)	1.55 (1.01, 2.38)	2.39 (1.38, 4.13)	0.89 (0.36, 1.26)	0.77 (0.51, 1.16)
Total family income last year						
<\$60,000	Ref	Ref	Ref	Ref	Ref	Ref
≥\$60,000	0.76 (0.47, 1.22)	0.75 (0.45, 1.26)	0.77 (0.51, 1.17)	0.69 (0.40, 1.18)	0.85 (0.60, 1.20)	0.89 (0.59, 1.34)
Level of education						
Some college or less	Ref	Ref	Ref	Ref	Ref	Ref
Bachelor's or graduate degree	0.75 (0.47, 1.21)	1.04 (0.62, 1.75)	0.60 (0.40, 0.91)	1.04 (0.61, 1.78)	1.39 (0.98, 1.97)	1.05 (0.69, 1.60)
Political ideology ^f	1.16 (1.01, 1.33)	1.15 (0.97, 1.36)	1.52 (1.35, 1.73)	1.24 (1.04, 1.47)	0.57 (0.51, 0.65)	0.62 (0.54, 0.71)
Disbelief in conspiracy theories ^g	0.70 (0.57, 0.86)	0.82 (0.66, 1.03)	0.45 (0.37, 0.55)	0.63 (0.51, 0.80)	1.47 (1.27, 1.71)	1.07 (0.89, 1.29)

OR=odds ratios, aOR=adjusted odds ratios.

^a Reference group: Participant intends to receive COVID-19 vaccine.^b Multinomial regression model.^c Reference group: low concern regarding climate change.^d Scale range:1 (low concern) to 20 (high concern).^e Scale range:1 (strongly trust) to 12 (strongly distrust).^f Range:1 (very liberal) to 7 (very conservative).^g Range:1 (strongly agree) to 5 (strongly disagree).

COVID-19 related information provided by public health sources (OR: 1.87, CI: 1.66–2.12), were politically conservative (OR: 1.52, CI: 1.35–1.73), female (OR: 1.55, CI: 1.01–2.38), and believed in conspiracies (OR: 0.45, CI: 0.37–0.55). By contrast, the odds of not getting the COVID-19 vaccine decreased for every unit increase in climate change attitudes (OR: 0.41, CI: 0.33–0.51), indicating higher concern regarding climate change, and if a participant had a college or graduate degree (OR: 0.60, CI: 0.40–0.91), compared to participants with some college education or less. After adjusting for other factors in the multivariable model, those with distrust of public health sources of COVID-19 information (aOR: 1.61, CI: 1.40–1.85), politically conservative ideology (aOR: 1.24, CI: 1.04–1.47), lower concern about climate change (aOR: 0.71, CI: 0.53–0.97), female sex (aOR: 2.39, CI: 1.38–4.13), and belief in conspiracy theories (aOR: 0.63, CI: 0.51–0.80) all continued to have higher odds of not intending to be vaccinated compared to those intending to get the COVID-19 vaccine.

Finally, similarly to those with low perceived risk of COVID-19 and poor engagement in prevention measures, individuals with significantly lower odds of concern for climate change had conservative political ideology (OR: 0.57, CI: 0.51–0.65) and distrust of public health sources of COVID-19 information (OR: 0.68, CI: 0.62–0.75) in the univariable analysis. High levels of disagreement with the statement “Much of what happens in the world today is decided by a small and secretive group of individuals” was associated with higher odd of high climate change concern (aOR: 1.47, CI: 1.27–1.71), compared to those who were supportive of the conspiracy theory. Only distrust of COVID-19 information (aOR: 0.75, CI: 0.67–0.83) and conservative ideology (aOR: 0.62, CI: 0.54–0.71) continued to be associated with significantly lower odds of climate change concern in the multivariable model.

Discussion

In the current study, we found that COVID-19 prevention behaviors (with the exception of ambivalent vaccine intentions) were significantly associated with climate change attitudes. After adjustment for political ideology, endorsement of conspiracy beliefs, trust in public health sources of COVID-19 information, and demographic variables, the associations between COVID-19 prevention behaviors and attitudes and climate change attitudes remained statistically significant.

There are several potential explanations for these findings on the relationship between climate change attitudes and COVID-19 behaviors and attitudes. One possible explanation for the identified associations is that there are additional factors not assessed that are correlated with both climate change attitudes and COVID-19 prevention behaviors. One domain we did not assess was specific sources of news information. Prior studies have shown news sources to be related to climate change attitudes and COVID-19 behaviors [42]. Unmeasured factors such as social identity and social norms may also help account for the association between climate change attitudes and COVID-19 prevention behaviors. Our inability to rule out alternative explanations to explain the association between climate change attitudes and COVID-19 prevention behaviors suggests there could be a constellation of attitudinal factors, beliefs, and cognitive biases that overlap. These components may include political ideology, news sources, peer influence, social and individual identity, and distrust in government, all of which may influence both climate change attitudes and COVID-19 behaviors.

Two of the items of climate change attitudes scale involved avoidance or lack of interest in the topic of climate change. This finding of the association between the climate change avoidance/interest items and the concern/impact items suggests that there may be motivative cognitions in climate attitudes that includes avoiding information on climate change which fits with prior research on motivative cognitions, political ideologies, and party affiliation [18,19]. This line of research suggests that we need to view climate change attitudes as more than a positive or negative valence at a given level of intensity. These attitudes are integrally linked to proclivity to engage in the topic. This association among the climate change attitude items also suggests that those who acknowledge climate change will need to start climate change conversations with those who avoid the topic. Moreover, discounting the severity of climate change should be viewed in context. Individuals may express that they have many competing priorities to address in their lives, and hence linking climate change to those priorities may be a viable method to reduce avoidance.

Hoffath and Hodson found that both climate change denial and denial that climate change was caused by humans were strongly associated with perceived environmentalism threat [41]. This construct of environmentalism threat contained items such as, “The American economy cannot remain dominant if we listen to

environmentalists,” and “Hard-working Americans are negatively impacted by environmentalists.” These sentiments are similar to concerns voiced by conservative leaders that an overreaction by public health officials and liberals to the pandemic led to a negative economic impact. Hence, it may be, in part, economic concerns that drive discounting of both climate change and the severity of the COVID-19 and appropriate prevention behaviors.

The role of political ideology in climate change attitudes is in line with prior climate change research, highlighting the importance of encouraging conservative leaders who are concerned about climate express publicly their views publicly. [43–46]. However, it may be more comfortable for many climate change advocates to affiliate with more politically like-minded individuals who may not be politically conservative. Involving political conservatives in establishing common concerns on climate change and developing feasible solutions is critical in order to develop sustainable change. Individual-level, voluntary solutions are likely to be more agreeable for those who have an individualistic perspective [47,48]. However, these approaches are clearly insufficient for addressing climate change and may be counterproductive if people believe that they are sufficient. Another approach to addressing the political polarization is to forge a new superordinate identity that includes a wide political spectrum, link political identity to pro-environmental outcomes such as sustained fishing and hunting for conservatives, or promote pro-environmental ingroup norms by comparisons to an outgroup [49].

Findings on the distrust of scientific news sources emphasize the importance of communication strategies in addition to mainstream media. Disseminating information on COVID-19 and climate change through informal and personal networks may be an effective way to reach those who distrust governmental information. Training individuals on initiating conversations about climate change or creating compelling climate change content on social media may be critical and novel avenues for reaching such individuals. In addition, discussions of climate change with family and friends are not normative for many individuals [50]. Hence, increasing these discussions can normalize such discourse and thereby increase its acceptability. Providing guidance on how to start such conversations is likely to be helpful. Still, there is a need for empirical data to test what approaches are most effective to foster and diffuse such conversations both via social media and in person. It is also well documented that conservative news sources such as Fox News have downplayed the severity of climate change and the severity of the COVID-19 pandemic [51,52]. We do not know if such news sources are in themselves influential or whether to be influential, it is necessary for them to be seen as an alternative to the mainstream narratives.

One reason for discounting climate change and COVID-19 severity may be that many individuals have inadequate mental models of these phenomena [53]. Mental models can be conceptualized as providing individuals with predictive and explanatory power for understanding the world, themselves, the tasks they perform, and their social and physical interactions [53]. Much of the focus on providing the public with mental models of climate change has been on communicating brief mechanistic models to describe climate change physics. There is evidence that this approach can change attitudes; however, these models do not focus on the impact of climate change on individuals or societies or provide information on how to mitigate climate change. Moreover, individuals may approach a topic with their own mental models. Prior research suggests that the term “environmentalists” often carries negative connotations, as this term may conjure up negative attributes [54,55]. It is therefore important to understand these negative mental models associated with climate change and mitigation. For example, components of mental models may include the belief that scientists, public health officials, or activists mandate and/or vilify certain behaviors or advocate for programs that will increase taxes and decrease competitive advantages.

Similarly, mechanistic models often include information on how greenhouse gases lead to climate change, which may promote feelings of helplessness or inability to take action. These models also do not discuss the potential social, health, and economic repercussions of climate change. Research on mental models suggests that three main criteria in providing conceptual models to individuals are learnability, functionality, and usability [56,57]. Rather than simply providing models that explain the mechanism of climate change, it may be beneficial to provide conceptual models of both the impact of climate change on factors that are important to the individual and suggest different approaches to addressing climate change. For example, for individuals concerned about impacts on the employment sector, information on types and quantities of high-paying jobs that can be implemented to address climate change, such as solar panel installers, may be helpful. For individuals with economic concerns, providing information emphasizing US leadership and the use of economic power, such as tariffs based on levels of greenhouse gasses, may be another salient approach. To address the nationalism rhetoric and threat of social change, mental models and communications could also incorporate nationalistic themes, such as emphasizing that American life will disappear if we do not tackle climate change and freedoms may be lost due to climate change disasters. In addition, models that include how individual-level behavior may lead to more macro-level change may help to motivate and engage people in climate change action.

While the majority of respondents believed that climate change would make the future of youth much worse, 32% were ambivalent or disagreed with this statement. These results were slightly higher than the 14% who reported very little or no concern about climate change. Providing information to help people understand the impact of climate change on younger generations may allow individuals to develop more accurate and accessible mental models of the impact of climate change on the health and well-being of future generations. For those who actively avoid climate change news and information, it is important to develop content that is easily disseminated and contain materials that may reduce avoidance. Future research should examine those topics that those who tend to avoid climate change are interested in viewing which, could be combined with climate change messages.

In addition to mental models that can address the concerns, beliefs, and values of climate change deniers and skeptics, it is critical to provide models of how to address climate change effectively and meaningfully. Two key aspects are (1) symbolic actions such as recycling that identify commitment and concern and (2) political action. Given the potential negative connotations of the label of environmentalist, materials that promote alternative social identities and social roles, such as parents protecting their children and future generations or individuals concerned about the future of their country, may have more appeal to certain groups than a focus on traditional environmentalist issues [49]. The sustainability triad that includes economic and social factors may also be a potentially beneficial model for addressing concerns of those who tend to have negative attitudes toward acknowledging and addressing climate change [58].

Although this was a cross-sectional study and, similar to other Mturk studies, assessed a predominantly white population which limits generalizability, the study results suggest that COVID-19 behaviors and attitudes and climate change attitudes are correlated, and that this association cannot be explained solely by measures of political conservatism, conspiracy beliefs, or trust in news sources. That is, even when these three variables were controlled for in adjusted models, there was still an association between COVID-19 behaviors and attitudes and climate change attitudes.

Future research is warranted on the interrelationship of climate change and COVID-19 perceptions, how to frame the topic of climate change to respond to those who discount and deny this existential threat, and how perceptions and mental models of climate change can lead to effective actions to mitigate climate change. This study

highlights that there are overlaps between those who discount climate change and the severity of the COVID-19 pandemic. Consequently, it should be anticipated that such individuals may be an impediment to addressing human and planetary health in the context of a pandemic and climate change.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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